21. (Amended) The apparatus according to claim 20, wherein said after-treatment chamber [comprises:] includes

a plasma generating section into which gas containing water vapor is introduced and into which a plasma generating means for generating a plasma in [said] the gas is connected[;], and

a treatment section which is connected to [said] the plasma generating section, [these] said plasma generating and treatment sections being divided from each other by a division wall in which are defined small openings through which neutral active species in a plasma pass [are provided], and [in] on which [said] the substrate is placed.

22. (Amended) The apparatus according to claim 20, wherein the gas containing water vapor is introduced into said after-treatment chamber[, said] with the substrate [is] placed therein, and said after-treatment chamber has parallel flat-plate type electrodes disposed on both sides of [said] the substrate with [said] the substrate located as a center thereof.

REMARKS

The official Office Action dated October 5, 1992, has been received and carefully noted. The above amendments and the following remarks are being submitted as a full and complete response thereto.

Claims 1-22 have been amended to more particularly point out and distinctly claim the subject invention. As such, claims 1-10

and 20-22 stand for consideration. As stated in the Office Action of October 5, 1992, claims 11-19 were considered allowable over the prior art. It is submitted that no new matter has been introduced.

The present invention as now claimed is directed to the apparatus and method for producing semiconductor integrated circuits. In one embodiment, the method of the invention incorporates the steps of selectively etching a metallic film formed on a surface of a substrate and exposed through a mask by using a gaseous etchant containing chlorine, bromine or a compound thereof after the metallic film is selectively covered with the mask made of a resist; and removing the mask used in the etching by ashing using a plasma generated in an atmosphere containing oxygen gas and water vapor. Also, chlorine, bromine or a compound thereof which are components of the gaseous etchant that remains on the surface of the metallic film exposed as a result of removing the mask are removed by forcing the gaseous etchant components to be released from the substrate.

In another embodiment, the method of the present invention includes, inter alia, the step of removing the mask used in the etching by ashing, wherein this step includes separately generating a plasma in a first atmosphere containing oxygen gas and in a second atmosphere containing water vapor, exposing the mask to neutral active species extracted from the plasma generated in the first atmosphere, and removing chlorine, bromine or a compound thereof which are components of a residual etchant exposed on the surface of the metallic film. The residual etchant components are

removed by exposing them to at least neutral active species in the plasma generated in the second atmosphere thereby forcing the residual etchant components to be released from the substrate.

In a third embodiment of the method of the present invention, the method incorporates the steps of selectively etching a metallic film exposed through a mask by using a gaseous etchant containing chlorine, bromine or a compound thereof after the metallic film formed on a surface of the substrate is selectively covered with the mask made of a resist; removing the mask used in the etching by ashing using a first plasma generated in an atmosphere containing oxygen gas; and removing the chlorine, bromine or a compound thereof which are components of a residual etchant on the surface of the metallic film exposed as a result of removing the mask. Removing the residual etchant components includes using a second plasma generated in an atmosphere containing a water vapor thereby forcing the residual etchant components to be released from the substrate.

In a fourth embodiment of the present invention, the apparatus for producing semiconductor integrated circuits incorporates an etching chamber having etching means for selectively etching a metallic film formed on a substrate and covered with a mask formed of a resist, an ashing chamber having ashing means for ashing the mask formed on the substrate, and an after-treatment chamber including an after-treatment means for removing residual chlorine, bromine or a compound thereof on a surface of the metallic film on the substrate. The etching means incorporates a gaseous etchant

containing chlorine, bromine or a compound thereof. The ashing chamber is connected through a first load lock chamber which is capable of making a vacuum, to the etching chamber. The ashing means incorporates a plasma generated in an atmosphere containing oxygen so as to remove the mask. The after-treatment chamber is connected to the ashing chamber through a second load lock chamber which is capable of making a vacuum. The after-treatment means incorporates a plasma generated in an atmosphere containing water vapor.

Claims 7-10 were rejected under 35 USC §112, first paragraph, in that the wording of claim 7 was considered to be confusing as to the exact sequence of steps. As outlined above, all the claims have been amended to more particularly point out and distinctly claim the subject invention, and to clarify the structure and process of the present invention as now claimed.

Claims 1-10 were rejected under 35 USC §103 as being unpatentable over Fujimoto et al in view of Shinagawa et al. Fujimoto et al was cited for showing a process for patterning an aluminum film located on a barrier metal layer on a semiconductor substrate beneath a pattern resist mask in a plasma comprised of a chlorine-based gas. However, Fujimoto et al was noted as not showing a specific ashing process. Shinagawa et al was cited for showing that ashing a resist layer at a temperature of 180°C in the neutral particles extracted from a plasma comprised of oxygen and water gases is desirable.

In contrast to the present invention, the reference of Fujimoto et al essentially comprises the three steps of etching, followed by anti-corrosion treatment, and lastly ashing and passivation. During the step of anti-corrosion treatment, corrosive matter is removed. The ashing and passivation step that follows the anti-corrosion treatment is thus irrelevant to removing the corrosive matter. Rather, removing the corrosive matter is conducted <u>prior</u> to the step of ashing. Fujimoto et al merely requires the passivation treatment for covering the residual corrosive matter which has not been removed from the prior passivation treatment.

In the present invention, the removal of the gaseous etchant components does not precede ashing, but is specifically stated as <u>following</u> the ashing or being conducted in an independent step <u>after</u> the ashing.

In addition, unlike the reference of Fujimoto et al, the present invention requires no passivation treatment like that of Fujimoto et al. Residual gaseous etchant components such as chlorine occur less in the present invention because the process of the invention has no influence on aluminum wiring patterns, and thus can be carried out until all residual chlorine is removed. In contrast, the anti-corrosion treatment in Fujimoto et al uses chlorine gas and must be stopped before aluminum wiring patterns can be damaged by chemical reaction with the chlorine gas. The presence of the corrosive chlorine gas mandates having a passivation treatment after the anti-corrosion treatment.

As described above, the reference of Fujimoto et al falls far short of either anticipating or rendering obvious each and every feature as now claimed by itself. The reference of Shinagawa et al is merely cited for showing the desirability of ashing a resist layer at a temperature of 180°C in neutral particles extracted from a plasma. This reference falls far short of providing any disclosure, teaching or suggestion that would make up for the deficiencies in the process of Fujimoto et al such that the combination of these two references could embody a process or structure even remotely similar to the present invention as claimed. In particular, neither of these references discloses, teaches or suggests the use of a plasma generated separately in a first atmosphere containing oxygen gas and then a second atmosphere containing a water vapor where the mask is exposed to neutral active species extracted from the plasma generated in the first atmosphere and removing the residual etchant components to at least the neutral active species in the plasma generated in the second atmosphere. Rather, the reference of Shinagawa et al appears to only show the process of ashing that uses a reactant gas composed of oxygen and a water vapor together.

All in all, applicants would strongly contend that the present invention as now claimed is distinguishable from the combination of Fujimoto et al and Shinagawa et al.

Claims 20-22 were rejected under 35 USC §103 as being unpatentable over Fujimoto et al in view of Galfo et al and Nogami. Fujimoto et al was cited for showing all the features of the

present invention except for the specific neutralization of corrosive chlorine residues following the ashing of the resist layer with a three-chambered apparatus with separate chambers dedicated for etching, ashing and neutralizing chlorine residues. Galfo et al was cited for showing the desirability of employing two separate process steps for conducting chlorine neutralization and resist ashing steps when patterning an aluminum layer on a semiconductor substrate. Nogami was cited for showing the use of an apparatus capable of extracting charged particles from plasma used to process a substrate.

As discussed above, applicants contend that the reference of Fujimoto et al by itself falls far short of either anticipating or rendering obvious each and every feature of the present invention as now claimed. Specifically, the reference of Fujimoto et al fails to show the structures of an etching chamber, an ashing chamber and an after-treatment chamber, wherein plasmas generated separately in a first atmosphere containing oxygen gas and in a second atmosphere containing a water vapor is used where the mask is exposed to neutral active species extracted from the plasma generated in the first atmosphere and removing the residual etchant components to at least the neutral active species in the plasma generated in the second atmosphere. As a matter of fact, Fujimoto et al specifically recites a structure wherein the etching treatment and anti-corrosion treatment carried out <u>in the same chamber</u> is a particular feature of its embodiments.

The reference of Galfo et al specifically recites the removal of absorbed chlorine and chlorine compounds to prevent the formation of free hydrogen chloride when the photoresist layer is removed from the aluminum film after plasma etching is completed, but prior to removal of the wafer from the etching chamber. As a matter of fact, Galfo et al notes that its passivation step of using fluorinated plasma can be incorporated into the automatic process sequence of the plasma etching equipment.

The reference of Nogami merely recites the use of a mesh that is charged with a floating potential or negative bias potential so as to suppress the flow of ions and electrons therethrough to a wafer.

Applicants strongly but respectfully contend that none of these cited references provides any disclosure, teaching or suggestion that would motivate their combination such that the combination of any or all of these references could embody a structure even remotely similar to the present invention as now claimed. In particular, both Fujimoto et al and Galfo et al recite the use of only a single chamber for the various process steps. As a matter of fact, both of these references particularly note the use of a single chamber for performing these steps to be a particular feature of their embodiments. Neither Galfo et al nor Nogami provides any disclosure, teaching or suggestion that would make up for the deficiencies in Fujimoto et al such that the combination of these references could embody a structure even remotely similar to the present invention as now claimed. The

combination of any and all of these references would produce both a structure and operation completely different from the present invention as now claimed.

Applicants would even contend that there is no basis for combining these references whereby the single chamber structure of Fujimoto et al with the single chamber structure of Galfo et al and the charged mesh of Nogami would embody a structure similar to the separate etching chamber, an ashing chamber and an after-treatment chamber of the present invention. The mere suggestion of the process being carried out in more than one step is insufficient to teach the use of a structure having several chambers. Applicants would submit that the only motivation for combining these references as such would be by hindsight knowledge of the present invention itself. Such a combination of references based on knowledge gleaned from the disclosure of the present invention constitutes an improper rejection.

Thus, applicants respectfully submit that the present invention as now claimed is distinguishable from the combination of Fujimoto et al, Galfo et al and Nogami.

Consequently, as shown above, certain clear differences exist between the present invention as now claimed and the prior art references cited. It is contended that these differences are more than sufficient that the present invention would not have been anticipated or rendered obvious given the prior are references. It is thus further contended that the present invention is allowable over the prior art.

In view of all of the above, it is respectfully requested that the Examiner withdraw the objections and rejections, indicate the allowability of the claims and pass this case to issue.

In the event this paper is not timely filed, applicant hereby petitions for an appropriate extension of time. The fee for any such extension may be charged to Deposit Account No. 14-1060, along with any other fees due or additional fees which may be required with respect to filing of this paper.

Respectfully submitted,

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